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Seeding Date Effects on Camelina Seed Yield and Quality Traits

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Seeding Date Effects on Camelina Seed Yield and Quality Traits

Abstract

An alternative crop with potential for dryland crop production in the Great Plains is camelina (*Camelina sativa L. Crantz*). Time of planting is an important management consideration that can affect camelina production. A study was carried out in the spring of 2013, 2014, and 2015 to evaluate seeding date effects on spring camelina varieties grown under dryland conditions in western Kansas. Three spring varieties (Blaine Creek, Pronghorn, and Shoshone) were planted at three seeding dates: early (April 3, 2013; March 17, 2014; and March 18, 2015); mid (April 16, 2013; April 1, 2014; and April 1, 2015); and late (April 30, 2013; April 15, 2014; and April 15, 2015). Parameters collected included time of flowering and physiological maturity, stand count at maturity, seed yield, biomass yield, harvest index, oil and protein content. Our findings indicate that seeding date can affect the time of flowering and physiological maturity, stand count, seed yield, biomass yield, harvest index, and protein content, but it did not affect oil content. Harvest index and oil content was significantly different among varieties. In general, mid and late seeding dates produced the highest yield across the three years. There were yield differences among varieties; Blaine Creek produced the highest seed yield and was significantly different from Pronghorn and Shoshone. Seed yield ranged between 340 and 440 lb/a. Average oil and protein content was 26% and 30%, respectively. Based on environmental factors and agronomic characteristics, camelina varieties were more productive when planted between early and mid-April.

Keywords

Camelina, variety, seeding date, quality traits

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Summary
An alternative crop with potential for dryland crop production in the Great Plains is camelina (*Camelina sativa L. Crantz*). Time of planting is an important management consideration that can affect camelina production. A study was carried out in the spring of 2013, 2014, and 2015 to evaluate seeding date effects on spring camelina varieties grown under dryland conditions in western Kansas. Three spring varieties (Blaine Creek, Pronghorn, and Shoshone) were planted at three seeding dates: early (April 3, 2013; March 17, 2014; and March 18, 2015); mid (April 16, 2013; April 1, 2014; and April 1, 2015); and late (April 30, 2013; April 15, 2014; and April 15, 2015). Parameters collected included time of flowering and physiological maturity, stand count at maturity, seed yield, biomass yield, harvest index, oil and protein content. Our findings indicate that seeding date can affect the time of flowering and physiological maturity, stand count, seed yield, biomass yield, harvest index, and protein content, but it did not affect oil content. Harvest index and oil content was significantly different among varieties. In general, mid and late seeding dates produced the highest yield across the three years. There were yield differences among varieties; Blaine Creek produced the highest seed yield and was significantly different from Pronghorn and Shoshone. Seed yield ranged between 340 and 440 lb/a. Average oil and protein content was 26% and 30%, respectively. Based on environmental factors and agronomic characteristics, camelina varieties were more productive when planted between early and mid-April.

Introduction
Identifying crops that are adapted to dryland environments of the central and northern Great Plains has been a major challenge. Conditions in western Kansas make camelina a potential candidate when it comes to intensifying wheat (cereal) cropping system. The crop has been reported to have low demand for water, fertilizer, and pesticide use compared with other oilseed crops. It has several uses, including biofuel production, and it can be used as an ingredient in animal rations, lubricants, adhesives, and other industrial applications. The crop is short-seasoned and resilient in water-limited environments, making it a suitable alternative in locations where it is not economical to grow high-value crops such as soybean, corn, and sunflower, which tend to use more water. Spring planting of camelina would fit in the winter wheat rotation system; it can be harvested early to allow for the planting of winter wheat, thereby increasing profitability of the whole system.

Efforts through the years have been targeted at characterizing the agronomic potential of camelina. In these efforts, planting date has been crucial because it affects crop yield potential. Research on camelina planting date has been conducted in different parts of the Great Plains. Early planting of winter camelina in October has been found to result in high yields and oil contents. In Nebraska, research indicates that yields are high when camelina is planted in late March through late April. In west central Minnesota, mid-April to mid-May has been conducive, depending on field conditions. Information on agronomic performance of camelina varieties and planting date information in Kansas is scarce; as a result, this study was carried out to identify the most productive varieties and also determine the best planting date to optimize camelina production.

Procedures

In spring 2013, 2014, and 2015, planting date effects on camelina varieties were studied at the Kansas State University Western Kansas Agriculture Research Center, Hays, KS. The varieties used in this study were Blaine Creek, Shoshone, and Pronghorn. These varieties were planted at three different dates in a split-plot design with three replications. Plot dimension was 30 ft × 10 ft, and seeds were planted at 5 lb/a. Seeding date was the main plot, and varieties were the subplot. Seeding dates are as follows:

Early (April 3, 2013; March 17, 2014; and March 18, 2015); mid (April 16, 2013; April 1, 2014; and April 1, 2015), and late (April 30, 2013; April 15, 2014, and April 15, 2015). The crops were rainfed throughout this study. Urea was applied as broadcast to each plot at 40 lb/a. In 2014 and 2015, data were collected on time of flowering and physiological maturity, stand count at maturity, seed yield, biomass yield, and harvest index. After harvest, the seeds were analyzed for oil and protein content using the *Antaris II FT-NIR* spectrophotometer *Analyzer*. All data were subjected to statistical analysis. Analysis was done with the ANOVA MIXED procedure in the SAS 9.3 software package (SAS Institute Inc., Cary, NC). Yield data collected for the three years were analyzed together, with variety and sowing date treated as fixed effects in the model.

Results

Time of Flowering and Physiological Maturity

In general, there was no significant difference in time of flowering among varieties for early and mid-seeding dates in 2014. At late seeding, Blaine Creek flowered later than Pronghorn and Shoshone (Table 2). In 2014, there were differences in time of physiological maturity among varieties for early, mid, and late seeding dates. Blaine Creek matured late across all three seeding dates, and maturity date was significantly different from Pronghorn and Shoshone. Pronghorn and Shoshone planted at early and late seeding dates matured at the same time. However, there was significant difference in time of maturity between mid-seeding Pronghorn and Shoshone varieties. In 2015, time of flowering within all seeding dates was not different among camelina varieties. There was no difference in time of physiological maturity among varieties in early and late seeding dates in 2015 (Table 2). The average time to physiological maturity among varieties was 92, 81, and 68 days after planting (DAP) for early, mid, and late seeding dates, respectively.

Stand Count, Seed, and Biomass Yield

Seeding date affected variety stand count in 2014. At early seeding, stand count for Blaine Creek and Shoshone were not significantly different; however, they were different from Pronghorn. Pronghorn had the highest stand count at mid-seeding and was statistically different from Blaine Creek and Shoshone. At late seeding date, Shoshone had the highest stand count and was statistically different from Pronghorn and Blaine Creek (Table 3). In 2015, there was no significant difference in stand count between varieties for early seeding date. Blaine Creek had the highest stand count for mid and late seeding dates and was significantly different from Pronghorn and Shoshone (Table 3).

Blaine Creek produced the highest seed yield and was significantly different from Pronghorn and Shoshone (Figure 1). Yield across varieties ranged from 340 to 440 lb/a. In 2013, seed yield across all seeding dates was not significantly different; however, in general the yield in 2013 was lower compared to the other years. This could be attributed to low precipitation in 2013 (Table 1). There were differences in seed yield among varieties in 2014 and 2015. In 2014, late seeding produced the highest camelina yield, and was significantly different from early seeding. Seed yield of mid and late seeding dates were not significantly different. In 2015, seed yield was not significantly different between mid and late seeding dates, but they were significantly different from early seeding date (Figure 2). Research indicates that camelina prefers cool temperatures. The high yields reported in 2014 and 2015 could be attributed to the relatively high soil moisture and lower air temperature during those years of the study compared to 2013 (Table 1).

In 2014, biomass produced for mid and late seeding dates were not significantly different, but they were different from early seeding date. In 2015, late seeding resulted in high biomass production, and was different from early and mid-seeding dates (Table 4). The cooler temperature at late seeding compared to early and mid-seeding dates temperatures could be a contributing factor (Table 1). In 2014, there was a significant difference in harvest index among seeding dates. Harvest index was highest for early seeding, and was significantly different from mid and late seeding dates (Table 4). In 2015, harvest index was highest for late seeding date and was significantly different from mid and early seeding dates (Table 4). At early seeding, harvest index was highest for Pronghorn and was significantly different from Blaine Creek and Shoshone. There was no difference in harvest index among varieties at mid-seeding date. At late seeding, harvest index was not significantly different for Blaine Creek and Shoshone, but they were different from Pronghorn (Table 5).

Camelina Oil and Protein Content

Oil content was different within seeding dates among varieties. At early and mid-seeding, Blaine Creek had the highest oil content and was significantly different from Pronghorn and Shoshone. At late seeding, Shoshone had the highest oil content and was significantly different from Blaine Creek and Pronghorn (Table 5). Oil content was not different among varieties in 2015, but there were differences in 2014 (Figure 3). Oil content was highest for Shoshone in 2014; however, it was not significantly different from Pronghorn. Oil content for Pronghorn and Blaine Creek were not significantly different from each other in 2014 (Figure 3). Average oil content for two years (2014 and 2015) across varieties was 26%.

In 2014, there was significant difference in protein content among varieties for early and mid-seeding dates. Pronghorn had the highest protein content at mid and early seeding dates and was significantly different from Shoshone. At late seeding, Blaine Creek had the highest protein content and was different from the other varieties (Table 4). In 2015, Pronghorn had the highest protein content at early seeding and was significantly different from Shoshone. At mid-seeding date, Blaine Creek had the highest protein content and was significantly different from Pronghorn and Shoshone. At late seeding, Pronghorn had the highest protein content and was statistically different from the other varieties. Average protein content for two years (2014 and 2015) across varieties was 30%.

Table 1. Growing degree days and accumulated rainfall during camelina growth cycle in 2013, 2014, and 2015

Year	Accumulated rainfall (in.)	Growing degree days (GDD) from planting to harvesting (°F)		
		Early	Mid	Late
2013	6.6	2820.0	2704.5	2538.5
2014	11.3	2460.5	2388.0	2260.0
2015	8.5	2552.5	2420.5	2196.0

Table 2. Time of flowering and physiological maturity of camelina varieties planted in spring 2014 and 2015

	Flowering time (dap)					
	2014			2015		
Variety	Early	Mid	Late	Early	Mid	Late
Blaine Creek	78	69	75	77	65	53
Pronghorn	78	69	64	77	66	54
Shoshone	78	69	71	77	66	53
Standard error	1.5	1.5	1.5	1.3	1.3	1.3

	Physiological maturity (dap)					
	2014			2015		
Variety	Early	Mid	Late	Early	Mid	Late
Blaine Creek	93	93	93	92	80.5	68.2
Pronghorn	90	88	85	92	81.0	69.0
Shoshone	90	93	85	92	81.0	68.7
Standard error	0.9	0.9	0.9	0.8	0.8	0.8

Table 3. Stand count and protein content of camelina varieties planted in spring 2014 and 2015

	Stand count (sq. ft.)					
	2014			2015		
Variety	Early	Mid	Late	Early	Mid	Late
Blaine Creek	4.9	3.7	5.5	1.3	6.3	6.5
Pronghorn	3.8	6.5	7.6	1.4	4.4	5.2
Shoshone	4.9	4.7	10.5	0.8	3.2	3.6
Standard error	0.9	1.0	0.9	0.7	0.7	0.7

	Protein content (%)					
	2014			2015		
Variety	Early	Mid	Late	Early	Mid	Late
Blaine Creek	29.8	30.0	30.7	29.7	29.7	29.5
Pronghorn	29.9	30.3	29.7	29.9	29.6	29.8
Shoshone	29.3	29.1	29.5	29.1	29.5	29.2
Standard error	0.2	0.2	0.2	0.2	0.1	0.1

Table 4. Harvest index and biomass yield of camelina varieties at different seeding dates in spring 2014 and 2015

	Harvest index		Biomass yield (lb/a)	
Seeding date	2014	2015	2014	2015
Early	0.23	0.11	1685.1	1615.8
Mid	0.21	0.15	2487.1	3704.1
Late	0.19	0.17	2597.6	3957.2
Standard error	0.02	0.01	230.5	185.7

Table 5. Harvest index and oil content of camelina varieties in spring 2014 and 2015

	Harvest index			Oil content (%)		
Variety	Early	Mid	Late	Early	Mid	Late
Blaine Creek	0.16	0.18	0.19	28.20	28.61	27.52
Pronghorn	0.20	0.17	0.15	27.70	27.34	27.97
Shoshone	0.15	0.18	0.21	27.06	28.02	28.78
Standard error	0.02	0.02	0.02	0.35	0.35	0.35

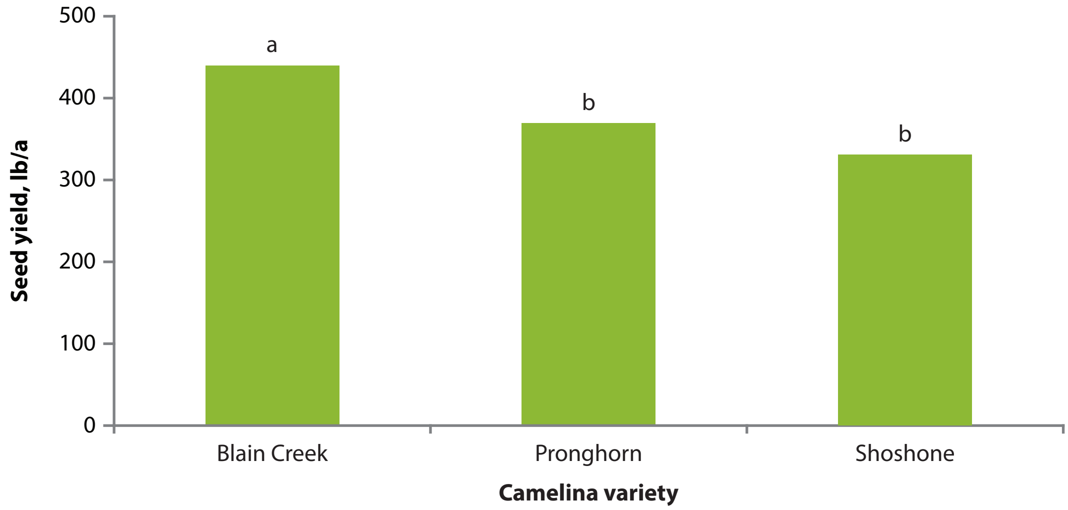

Figure 1. Average camelina variety yield across three years (2013, 2014, and 2015), Agricultural Research Center–Hays. Means followed by the same letter(s) are not significantly different at P>0.05

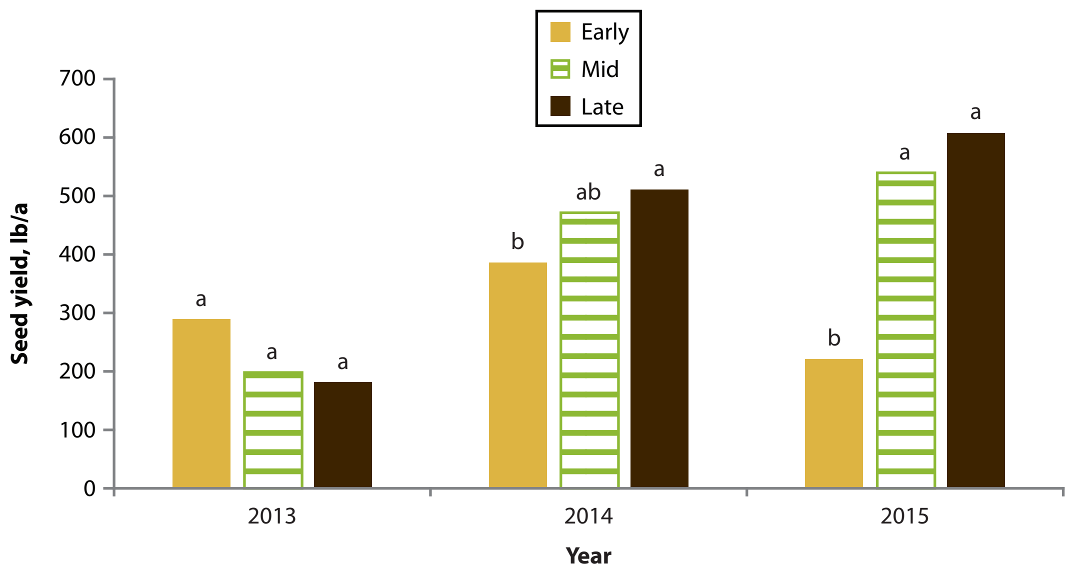

Figure 2. Camelina yield at early, mid, and late seeding dates in year 2013, 2014, and 2015, Agricultural Research Center–Hays; comparison is among planting dates within year. Within years, means followed by the same letter(s) are not significantly different at P>0.05.

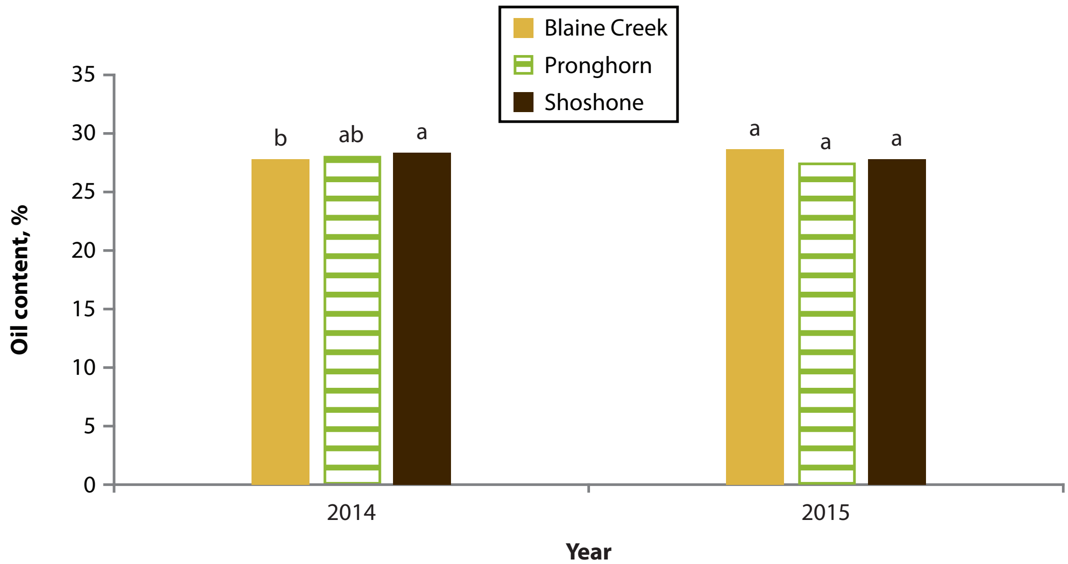

Figure 3. Average oil content of camelina varieties in 2014 and 2015, Agricultural Research Center–Hays; comparison is among varieties within year. Within years, means followed by the same letter(s) are not significantly different at P>0.05.